Original Article

Cesarean Spinal Delivery & Hypertension

Evaluation of Heart Rate Variability and Baroreflex Sensitivity in Cesarean Spinal Delivery

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ABSTRACT

Objective: To appraise that objective heart rate variations, can predict hypotension following block, in parturients undergoing spinal cesarean delivery.

Study Design: Observational study.

Place and Duration of Study: This study was conducted at the Anesthesia Department, Islam Teaching Hospital, Islam Medical College, Sialkot from 03-4-2012 to 18-9-2012.

Materials and Methods: One hundred and twenty eight term parturients scheduled for spinal cesarean delivery, with American Society of Anesthesiologists (ASA) physical status class 1-3 were inducted in the study. Pre-anesthetic assessment was done and informed written consent taken. Excluded were parturients with contraindications of regional anesthesia.

Results: Spearman's Rank correlation co-efficient (r) value came out to be 0.326 and significant at 0.01 level. Objective observation of heart rate variations i.e baseline and immediately following intra-thecal block along with baroreceptor response (ratio of changes in heart rate to change in systolic blood pressure) were noted in 128 term parturients undergoing spinal cesarean section.

Conclusion: The objective observation of heart rate changes following spinal sympathetic block correlated with subsequent systolic blood pressure patterns, representing autonomic (sympathetic and parasympathetic) efferent influences on heart.The hemodynamic changes also guided further management, thus help in lowering severity of maternal hypotension and reducing maternal morbidity.

Key Words: Baroreflex, Spinal, Cesarean, Heart Rate

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INTRODUCTION

The maternal hypotension incidence in spinal anesthesia is said to be around 82%[1] when preventive measures are not adopted, even with the application of said techniques the prevalence still ranges from 53[2] to 80%[3].

Historically administering intra-venous crystalloid fluids 15 to 30 minutes earlier to spinal anesthesia known as "preload" was considered as part of approach and practiced to counteract sympathetic block hypotension for many years, when first presented as part of protocol by Greiss FC Jr and Crandell DL[4].In a randomized controlled study by Morgan PJ, Halpern SH[5] and colleagues affirmed that incidence of maternal hypotension associated with spinal anesthesia, employing crystalloid fluids pre-load to vary around 46%.

At present infusing intra-venous fluids at time of induction of spinal anesthesia known as "coload" is receiving particular attention as it appears physiologically more appealing in preventing post spinal hypotension as suggested by Mercier FJ, Roger-Christoph S[6] and colleagues, in their study. In study by Ewaldsson CA and Hahn RG[7] on volume kinetics, pushing ringer lactate solution at time of induction of anesthesia helped in better management of homeostatic levels of arterial blood pressures than a pre-load fluid use.

The incidence in central neuraxial anesthesia of profound badycardia and cardiac arrest is stated to be around 1.5 per ten thousand cases, by contrast cardiac arrest incidence during general anesthesia is approximately 5.5 per 10,000 cases[8].Local anesthetic agents injected into cerebro-spinal fluid cause blockade of neural transmission in posterior (somatic, visceral sensations) and anterior (efferent motor and autonomic outflow) nerve roots. The baroreceptor reflex is responsible for maintenance of arterial blood pressure so that marked changes are avoided, these changes are sensed by stretch receptors in carotid sinus and aortic

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arch, the nuclues solitarius in medulla receive impulses, via afferent signals of glossopharyngeal and vagus nerve, a rise in blood pressure elicits parasympathetic system activation and sympathetic inhibition resulting in decrease in heart rate, cardiac contractility and lower vascular resistance[9] and vice versa. Pre-operative anxiety effect in parturients was assessed by visual analogue scale before spinal anesthesia in a study by Orbach-Zinger S Ginosar Y[10] and colleagues advocating that it projected into maternal hypotension following block.Various measures have been suggested to counter spinal attributed maternal hypotension like,fluid(pre-loading/co-loading),giving vasopressors (phenylephrine or ephedrine) and posture change[11].

Heart rate variability can be employed in predicting spinal induced maternal hypotension was first time-honored by Chamchad D, Arkoosh VA[12] et al in their study.Increased sympathetic drive in parturients before spinal anesthesia is associated with intra-operative hypotension following sympathetic block in cesarean section was demonstrated by Hanns R, Bein B, Ledowski T[13]and colleagues in their study. Baroreflex sensitivity is the ratio of change in heart rate to change in systolic blood pressure and the autonomic efferent influences acting on heart rate (sympathetic and parasympathetic systems) are responsible for the said changes[14].

The present study was designed to test the hypothesis, that objective observation of heart rate variations i.e baseline and immediately following spinal block are predictive of maternal hypotension after block and guide treatment regimen and management thereby reducing incidence and severity of maternal hypotension. Baroreceptor reflex changes (pulse and blood pressure) were objectively observed following block. Additional outcome variables like vasopressor need, atropine used, maternal nausea and vomiting, fetal Apgar score[15] and associated complications were noted. The vasopressor were used in study when 20% decline in systolic blood pressure occurred from baseline (or < 90mmHg) and supplemental venturi oxygen facemask were used for pulse oximeter reading <95% on air and atropine was used to treat bradycardia (heart rate of less than 50 beats/minute).

MATERIALS AND METHODS

Ethical committee approval was taken and study done from 03-4-2012 to 18-9-2012 at the Anesthesia Department of the Islam Teaching Hospital, Islam Medical College, Pasroor road, Sialkot. One hundred and twenty eight term parturients scheduled for spinal cesarean delivery, with American Society of Anesthesiologists (ASA) physical status class 1-3 were inducted in the study. Pre-anesthetic assessment was done and informed written consent taken. Excluded were parturients with contraindications of regional anesthesia. After securing two large bore intravenous lines, standard monitors (electro-cardiogaph, pulse oximetry, and non-invasive blood pressure) were attached and baseline readings noted. Sub-arachnoid block done with 0.75% hyperbaric bupivacaine in left lateral position employing standard aseptic technique and later placed supine with 15º wedge under the right hip for few minutes.The motor block was evaluated by modified bromage scale by Breen TW, Shapiro T[16] and colleagues. Neuraxial block assessment was done at one minute interval and procedure started when T6 dermatome level was attained to both cold (sympathetic) and pin prick (sensory) check. The heart rate changes were noted every 30 seconds alongwith blood pressure measurement every minute for fifteen minutes than at five minutes interval. After procedure hemodynamic monitoring and care of spinal anesthesia continued in post anesthesia care unit. SPSS version 19 was used for statistical analysis. Spearman's Rank correlation was employed to check interdependence (correlation) between the variables i.e. heart rate and blood pressure variations following block and significance noted at 0.01 level.

RESULTS

The mean age (years) in study being 15.91(SD of 4.18), median and mode being 25, whereas minimum and maximum age being 18 and 40 years. The mean fetal Apgar score[15] at one and five minutes was 6.9(SD of 1.59) and 8.5(SD of 1.90).In study vasopressor's were used in 63 (in 49.2%) and not used in 65(in 50.7%) cases. Injection metoclopramide was given for nausea in 11(in 8.5%) of cases. The patient's categorized in ASA grade 1, 2, 3 were 113(88.2%), 6(4.6%) and 9(7.03%) respectively.

Table No.1: Atropine consumption.

	Number	Percent
Prophylactic Atropine	6	4.68
For bradycardia after block	54	42.18
For missed beats	2	1.56
No Atropine used	66	55.15

Table No.2: Hemodynamic patterns.

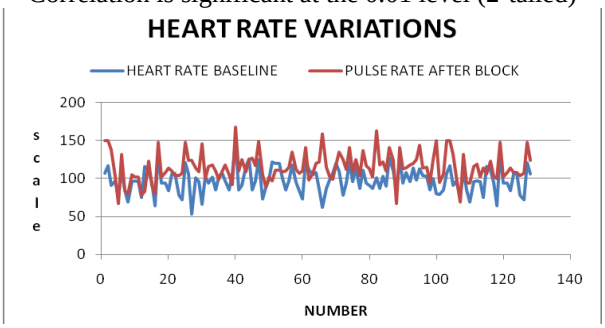
	Frequency	Percentage
Tachycardia alongwith hypotension	22	17.2
Bradycardia alongwith hypotension	2	1.6
Little or no hemodynamic change	96	75
Stable heart rate, only unopposed hypotension	8	6.3

The heart rate variation and systolic blood pressure changes baseline and following block are depicted in graph-1 and 2 respectively.Table-1 show atropine used. The objective hemodynamic (heart rate and blood pressure) variation patterns observed in the study following block are shown in table-2. Baroreflex sensitivity heart rate (beats per minute) to change in systolic blood pressure (mmHg) variations are shown in graph-3. Spearman's Rank correlation test applied is depicted in table-3, the value of correlation co-efficient(r) is .326 and correlation is significant at the 0.01 level. The total mean pre-load volume in millilitres 1551 ml (SD of 474ml), and mean dose hyperbaric bupivacaine being 13.6mg (SD of 0.54) in the study.

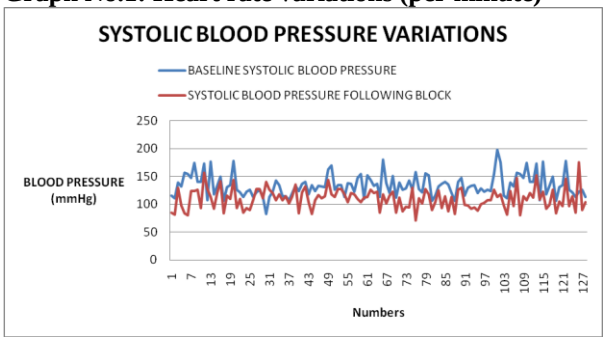
Table No.3: Spearman's Rank Correlation.

			Heart rate/ minute after block	Systolic blood pressure (mmHg) following block
Spearman's rho	Heart rate after block	Correlation Coefficient	1.000	- .326 **
		Sig. (2-tailed)	.	.000
		N	128	128
	Systolic blood pressure	Correlation Coefficient	- .326 **	1.000
		Sig. (2-tailed)	.000	.
		N	128	128

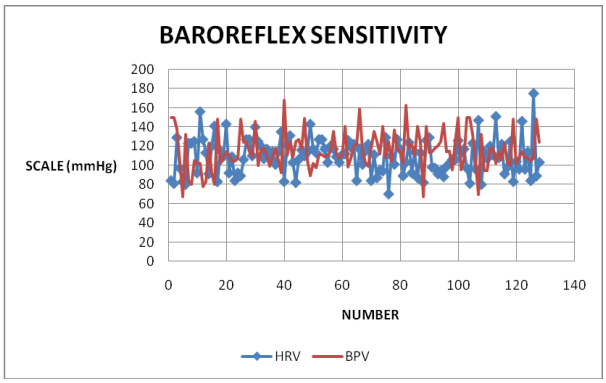
**Correlation is significant at the 0.01 level (2-tailed)



Graph No.1: Heart rate variations (per minute)



Graph No.2: Systolic blood pressure changes (mmHg).



Graph No.3: Baroreflex sensitivity.

DISCUSSION

As no autoregulation of placental blood flow exists, a decrease in maternal arterial pressure will lower its perfusion while increased sympathetic and decreased parasympathetic activity is observed in pregnancy[17] though this is helpful in maintaining placental perfusion during pregnancy[18] but this places parturient prone to hypotension following sympathetic block. A second highly potent endogenous vasodilator system other than arterial baroreflex is the nitric oxide system which acts through feedback mechanism stimulated by shear stress induced by high arterial pressure and is a short term regulatory system[19]. Mackey DC, Carpenter RL[20]and colleagues in their study stated, the cardiovascular reflexes involved in spinal associated sympathetic block hypotension (decreased venous return), are, pacemaker stretch reflex (decreased stretch result in bradycardia), activation of vagal reflex arcs mediated by baroreceptors, and the Bezold-Jarisch reflex[21] (stretch receptors in the sinus node result in a paradoxical Bezold-Jarisch response).The sympathetic outflow of heart arises from cervical 5th to thoracic 5th level with main supply of heart is from thoracic 1st to 4thlevel.Another possible mechanism of bradycardia and asystole during spinal anesthesia is the blockade of the stated cardio-accelerator fibres this may alter balance of autonomic nervous system input to the heart resulting in unopposed parasympathetic influence on the sinoatrial and atrioventricular nodes. Brown DL, Carpenter RL[22] and colleagues in their study advocated to use anticholinergic agents like atropine, and vasopressors in a step ladder pattern, when bradycardia and hypotension presents after intra-thecal block and successful resuscitation has been documented in majority of cases where atropine was used as first agent in the line of therapy[23] though in few cases if bradycardia is accompained by hypotension, anticholinergic agent (atropine) use will put in view un-corrected hypotension to manage[24].Similar protocol for hemodynamic changes management following spinal block was utilized in our study as guided by observing heart rate variability changes after sympathetic block. In the study in a single case, oxygen supplementation

for respiratory distress via tight face mask assisted manual breathing was needed for a minute period. There was no neurological deficit in any case in our study in post-operative follow up.

A study by Bishop DG, Cairns C[25] and colleagues advocated that pre-operative heart rate variability analysis forecasts subsequent spinal block hypotension in parturients. Sakata K, Yoshimura N [26] and colleagues in their study stated, that changing posture alongwith employing heart rate variation analysis is helpful in predicting hypotension risk in parturients undergoing spinal cesarean delivery.Yokose M, Mihara T[27] and colleagues in a prospective observational study, evaluated pre-operative clinical value of non-invasive pulse oximetry derived variables e.g perfusion index, heart rate, etc and commented that pre-operative heart rate can be predictable of subsequent spinal associated hypotension in parturients.A related study by Toyama S, Kakumoto M[28] et al on prediction of perfusion index readings evaluated from pulse oximetry monitoring, stating that a high perfusion index readings correlates with lower blood pressure(hypotension) following block in spinal cesarean delivery. Jain R, Agarwal A, and Yadav S[29], studied blood pressure readings before spinal anesthesia in lateral and sitting postion and pointed that the baseline values in lateral position correlated moderately with blood pressure readings post spinal in the supine position.

CONCLUSION

The objective observation of heart rate changes following spinal sympathetic block correlated with subsequent systolic blood pressure patterns, representing autonomic (sympathetic and parasympathetic) efferent influences on heart.The hemodynamic changes also guided further management, thus help in lowering severity of maternal hypotension and reducing maternal morbidity.A large multicenter trial at national level is need of time to assess heart rate variability analysis in prediction of post spinal hypotension.

Author's Contribution:

Concept & Design of Study:	Dr. Muhammad Salman Maqbool
Drafting:	Dr. Muhammad Salman Maqbool
Data Analysis:	Dr. Muhammad Salman Maqbool
Revisiting Critically:	Dr. Muhammad Salman Maqbool
Final Approval of version:	Dr. Muhammad Salman Maqbool

Conflict of Interest: The study has no conflict of interest to declare by any author.

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